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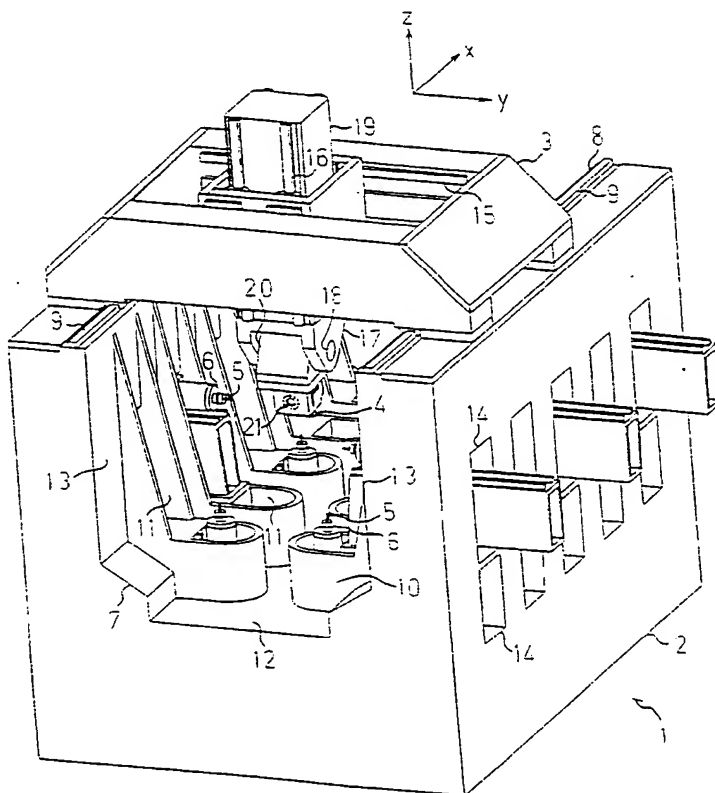
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0002425-7 28 June 2000 (28.06.2000) SE(71) Applicant (for all designated States except US): **MODIG MACHINE TOOL AB** [SE/SE]; Box 20, S-570 80 Virserum (SE).

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(75) Inventor/Applicant (for US only): **MODIG, Percy** [SE/SE]; Evagatan 10, S-570 80 Virserum (SE).(81) Designated States (*national*): AE, AG, AL, AM, AT, AT (utility model), AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, CZ (utility model), DE, DE (utility model), DK, DK (utility model), DM, DZ, EC, EE, EE (utility model), ES, FI, FI (utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (utility model), SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

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(54) Title: MULTI OPERATION MACHINE WITH AN U-SHAPED FRAME WITH SEVERAL APERTURES



(57) Abstract: A multi-operation machine (1) comprises a machine frame (2), a holder (3), which is arranged to hold a workpiece (4) and to move said workpiece during machining thereof along three axes constituting a first (x), a second (y) and a third (z) axis of a three-dimensional co-ordinate system, and at least two tools (5), which are each fitted to a support (6) and which are arranged to machine the workpiece (4) in sequence while this is being displaced by means of the holder (3). Each support (6) is arranged to assume a fixed position relative to the machine frame (2) while the workpiece (4) is being machined by the associated tool (5). The machine frame (2) has the shape of an upwardly open U-shaped channel (7) over which the support (3) extends like an overhead crane and which has a bottom portion (10) in which the supports (6) are arranged.

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*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

Multi operation Machine with an U-shaped frame with several apertures.

### Field of the Invention

The present invention relates to a multi-operation machine, comprising a machine frame, a holder, which is arranged to hold a workpiece and to move said workpiece  
5 during machining thereof along three axes constituting a first, a second and a third axis of a three-dimensional coordinate system, and at least two tools, which each are fitted to a support and which are arranged to machine the workpiece in sequence while this is being displaced by  
10 means of the holder, each support being arranged to assume a fixed position relative to the machine frame while the workpiece is being machined by the associated tool.

### Background Art

15 US 5,486,151 discloses a multi-operation machine according to the introduction. This machine has two prominent features which distinguish it from prior-art machines of this type. First, in this machine the supports consist of two spindles, which are arranged to  
20 drive tools for machining a workpiece that are interchangeable by means of tool changers. The advantage of this arrangement is that the time required for a tool change in one of the spindles can be used to machine the workpiece by means of the tool on the other spindle.  
25 Second, in this machine the spindles are intended to assume a fixed position relative to the machine frame during machining of the workpiece. The advantage here is that it is easier to control the machine since it is always the same machine element, namely the holder, that  
30 is moved during machining.

A disadvantage of the prior-art machine is that the machining opportunities offered by these two spindles are not optimal, since it is not possible to achieve an ade-

quate driving of all the tools available with only two spindles.

### Object of the Invention

5 In view of the above, it is an object of the invention to provide an improved multi-operation machine, which in an extremely simple way allows an optimisation of both the number and the design of supports for tools intended for machining a workpiece.

### Summary of the Invention

10 According to the invention, this object is achieved in a multi-operation machine as described by way of introduction by the machine frame having the shape of an upwardly open U-shaped channel over which the support extends like an overhead crane and which has a bottom  
15 portion in which the supports are arranged. Owing to the solution according to the invention involving a holder in the form of an overhead crane and a U-shaped channel, a space that is unaffected by the holder is formed in the bottom portion of the channel, in which space it is possible  
20 to arrange a suitable number of supports of a suitable type.

Certainly, US 5,699,598 discloses a machine tool having a machine frame in which two guide rails are horizontally arranged parallel to each other above a machining  
25 space, but this space does not have the shape of a channel, but rather of a chamber that is centred about a turret arranged in the chamber. The machine tool in question further comprises two interacting slides supporting two separate spindles, the interaction between the slides  
30 making it impossible to move the slides in any other direction than the directions X and Z as indicated.

In this connection, the supports are preferably each arranged in one of a plurality of openings in the bottom portion of the channel and are displaceable between a  
35 working position, in which the associated tool is located within a machining zone for machining the workpiece, and a resting position, in which the associated tool is

located outside said machining zone. The advantage of this solution is that the openings create even more space for supports in the bottom portion of the channel.

Furthermore, the bottom portion of the channel preferably comprises a horizontal bottom wall and two vertical side walls rising parallel to each other on both sides of the bottom wall, the openings being formed partly in said bottom wall and partly in said side walls. The advantage of this is that it is possible to provide, in an extremely simple way, supports for both horizontally and vertically oriented tools.

Moreover, the openings are preferably tunnel-shaped and the supports comprise brackets for mounting therein. The advantage of this is that the assembly and disassembly of the supports is thus considerably facilitated.

In addition, the openings preferably have apertures on the outside of the channel and the supports are exchangeable from the outside of the channel through these apertures. The advantage of this solution is that the accessibility of the supports is considerably improved and that it is possible, if desired, to assemble or disassemble a support during operation of the machine.

The third axis is preferably vertical and the holder is arranged to rotate the workpiece about this axis. In addition, the holder is preferably arranged to rotate the workpiece about a horizontal pivot shaft, which is rotatable about the vertical axis and parallel to a plane through said first and second axes. Moreover, the holder is preferably arranged to rotate the workpiece about a further pivot shaft, which is perpendicular to said vertical axis and said horizontal pivot shaft. The advantages of these further axes of movement are that each of them improves the possibilities of machining the workpiece.

Preferably, at least one of the supports comprises a tool changer, which is arranged to switch, in said

resting position, between at least two tools. The advantage of this is that it is thus possible to easily switch to a new tool when the old one is worn out or to a different type of tool while another of the machine's tools is in operation.

In an embodiment of the invention, at least one of the supports is a spindle unit, which is arranged to rotate a tool. Preferably, however, a plurality of spindle units are provided, each spindle unit having properties adapted to the associated tool/tools. The advantage of having specially adapted spindle units is that they allow optimal machining of a workpiece in terms of time expenditure and product quality.

#### Brief Description of the Drawings

A preferred embodiment of the invention will be described in more detail below with reference to the accompanying drawings, in which

Fig. 1 is a perspective view of a preferred embodiment of the multi-operation machine according to the invention;

Fig. 2 is a perspective view of a tool spindle for tool changing intended for the multi-operation machine; and

Fig. 3 is a perspective view of the tool spindle in a resting position.

#### Description of a Preferred Embodiment

With reference to Fig. 1, the multi-operation machine 1 has a machine frame 2. A holder 3, which is carried by the machine frame 2, is arranged to hold a workpiece 4 and to move said workpiece 4 during machining thereof in the machine 1 along three axes constituting a first x, a second y and a third z axis of a three-dimensional, orthogonal coordinate system. Inside the machine, a plurality of rotating tools 5 are provided, each of which is clamped in a spindle 6. The tools 5 are arranged to machine the workpiece 4 in sequence while this is being moved by means of the holder 3, each spindle 6 being

arranged to assume a fixed position relative to the machine frame 2 while the workpiece 4 is being machined by the tool 5 associated with the operating spindle 6.

As shown, the machine frame 2 has the shape of a upwardly (in the z-direction) open U-shaped channel 7 over which the support 3 extends like an overhead crane, i.e. it bridges the upper opening 8 of the channel 7, rails 9 extending in the x-direction and intended for the displacement of the holder 3 in this direction encompassing said opening 8. In addition, the channel 7 has a bottom portion 10, in which the spindles 6 are arranged.

More particularly, the spindles 6 are each arranged in one of a plurality of openings 11 in the bottom portion 10 of the channel 7. This bottom portion 10 comprises a horizontal bottom wall 12 and two vertical side walls 13 rising parallel to each other on both sides of the bottom wall 12. The openings 11 are formed partly in said bottom wall 12 and partly in said side walls 13, said openings 11 being tunnel-shaped and having apertures 14 which are positioned on the outside of the machine frame 2 or the channel 7 and through which the spindles 6 are exchangeable.

In addition to the three axes of displacement x, y and z, which are defined by the rails 9 mentioned above and by horizontal rails 15 extending in the x-direction and vertical rails 16 extending in the z-direction, the holder 3 also has three axes of rotation. The first axis of rotation is defined by the axis z and extends through the centre of a central column 19 of the holder 3, which column is vertically displaceable by means of the rails 16, and allows a fork 17 mounted on the column 19 and associated with the holder 3 to be rotated about the axis z. The second one of these axes of rotation is horizontal, i.e. extends in the x-y plane, and extends through the centre of a journal 18 carried on the fork 17, a further holder element 20 being pivotally carried on said journal 18. The third one of these axes of rotation ex-

tends through the centre of a journal 21, which is carried on the holder element 20, and is perpendicular to both the axis z and the journal 18 and allows the work-piece 4 to be pivoted in an additional manner.

5           With reference to Figs 2 and 3, one of the tool spindles 6 is shown in more detail. It comprises a driving unit 22, which via a driving belt 23 drives a shaft 24. On the shaft 24, one of four tools 5 can be mounted by means of a tool changer 25. The tool changer  
10 25 comprises a tool holder 26 in the form of a circular disc formed with holes 27 for the tools 5 and is displaceable on rails 28 by means of a piston assembly 29 between a changing position, as shown in Fig. 2, and a resting position, as shown in Fig. 3. The rails 28 are  
15 advantageously placed on a bracket 30, which is used to fix the tool spindle 6 in one of the tunnel-shaped openings 11 shown in Fig. 1.

As is evident from Figs. 2 and 3, particularly the vertically oriented tool spindles 6 may also be displace-  
20 able between a working position, as shown in Fig. 2, and a resting position, as shown in Fig. 3. In order to protect in a reliable manner the spindle 6 and a tool 5 clamped therein in the resting position, the driving unit 22 and the elements driven thereby are displaceably ar-  
25 ranged, as illustrated, by means of a piston assembly 31 in a protective cover 32, which in the resting position is sealable by means of a lid 33.

It will be obvious to the person skilled in the art that the multi-operation machine 1 described above may be  
30 varied in different ways within the scope of the claims, particularly as regards the spindles 6, which may very well consist of some other form of tool holder.



## CLAIMS

1. A multi-operation machine, comprising a machine  
5 frame (2), a holder (3), which is arranged to hold a  
workpiece (4) and to move said workpiece during machining  
thereof along three axes constituting a first (x), a  
second (y) and a third (z) axis of a three-dimensional  
coordinate system, and at least two tools (5), which are  
10 each fitted to a support (6) and which are arranged to  
machine the workpiece (4) in sequence while this is being  
moved by means of the holder (3), each support (6) being  
arranged to assume a fixed position relative to the ma-  
chine frame (2) while the workpiece (4) is being machined  
15 by the associated tool (5), c h a r a c t e r i s e d in  
that the machine frame (2) has the shape of an upwardly  
open U-shaped channel (7) over which the holder (3) ex-  
tends like an overhead crane and which has a bottom  
portion (10) in which the supports (6) are arranged.

20 2. A machine according to claim 1, c h a r a c -  
t e r i s e d in that the supports (6) are each arranged  
in one of a plurality of openings (11) in the bottom por-  
tion (10) of the channel (7) and that they are displace-  
able between a working position, in which the associated  
25 tool (5) is located within a machining zone for machining  
the workpiece (4), and a resting position, in which the  
associated tool (5) is located outside said machining  
zone.

3. A machine according to claim 2, c h a r a c -  
30 t e r i s e d in that the bottom portion (10) of the  
channel (7) comprises a horizontal bottom wall (12) and  
two vertical side walls (13) rising parallel to each  
other on both sides of the bottom wall (12), the openings  
(11) being formed partly in said bottom wall (12) and  
35 partly in said side walls (13).

4. A machine according to claim 2 or 3, c h a r -  
a c t e r i s e d in that the openings (11) are tunnel-

shaped and that the supports (6) comprise brackets (30) for attachment therein.

5        5. A machine according to any one of claims 2-4, characterised in that the openings (11) have apertures (14) on the outside of the channel (7) and that the supports (6) are exchangeable from the outside of the channel (7) through these apertures (14).

10       6. A machine according to any one of claims 1-5, characterised in that said third axis (z) is vertical and that the holder (3) is arranged to rotate the workpiece (4) about this axis.

15       7. A machine according to claim 6, characterised in that the holder (3) is arranged to rotate the workpiece (4) about a horizontal pivot shaft (18), which is rotatable about the vertical axis (z) and parallel to a plane through said first and second axes (x, y).

20       8. A machine according to claim 7, characterised in that the holder (3) is arranged to rotate the workpiece (4) about a further pivot shaft (21), which is perpendicular to said vertical axis (z) and said pivot shaft (18).

25       9. A machine according to any one of claims 1-8, characterised in that at least one of the supports (6) comprises a tool changer (25), which is arranged to change, in said resting position, between at least two tools (5).

30       10. A machine according to any one of claims 1-9, characterised in that at least one of the supports is a spindle unit (6), which is arranged to rotate a tool (5).

35       11. A machine according to claim 10, characterised in that a plurality of spindle units (6) are provided, each spindle unit (6) having properties specially adapted to the associated tool/tools (5).

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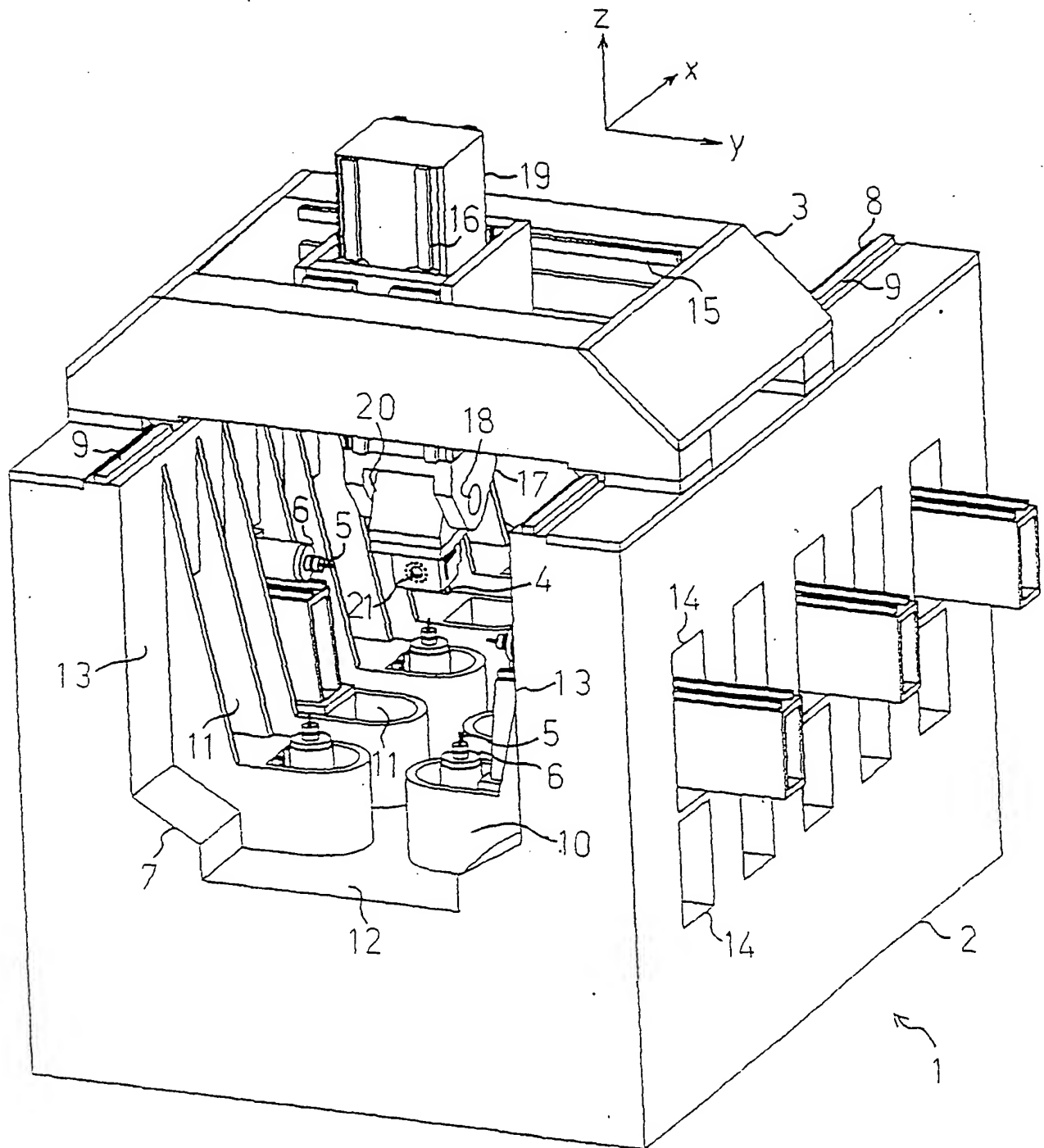
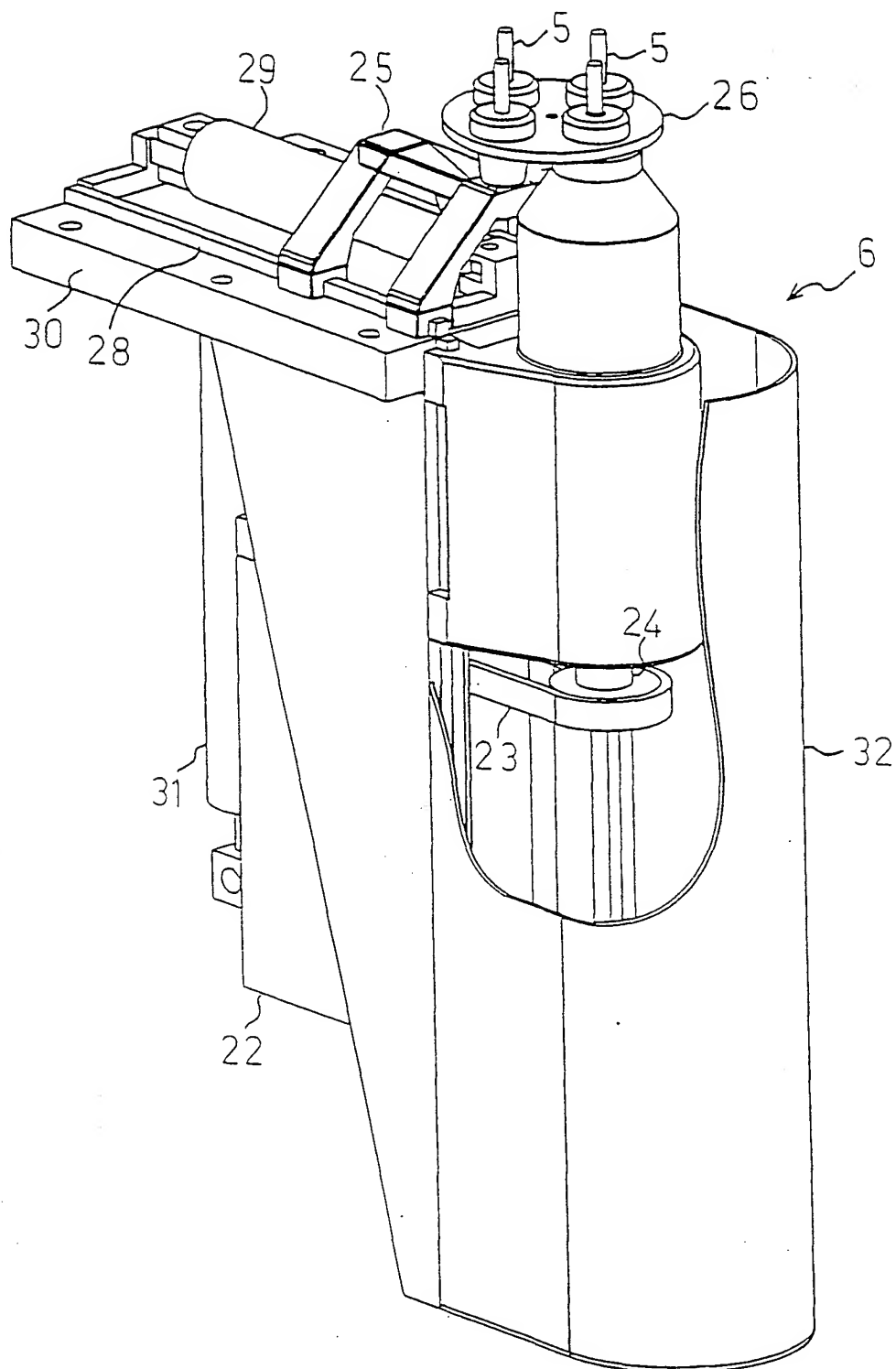
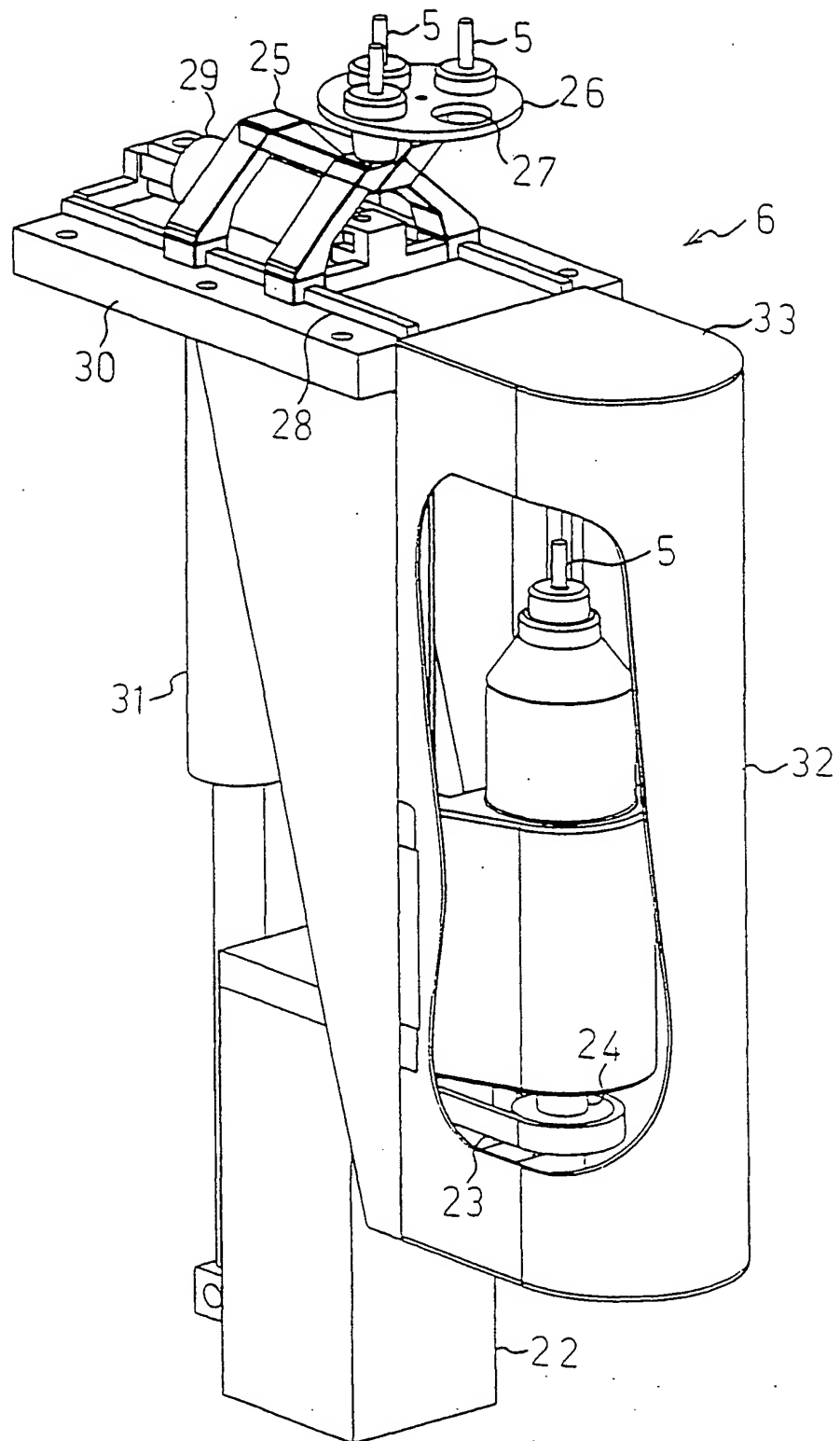


FIG 1

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FIG 2

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FIG 3

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 01/01481

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B23Q 39/02

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B23Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI-DATA

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5699598 A (NORBERT HESSBRÜGGEN ET AL), 23 December 1997 (23.12.97), column 3, line 36 - column 4, line 62, figure 2, abstract	1-9
Y	--	10-11
Y	DE 19725043 A1 (TORSTEN SCHIRMER GMBH & CO. KG), 17 December 1998 (17.12.98), column 1, line 27 - line 34, figure 3	10-11
A	DE 19526616 A1 (DORNER, REINER ET AL), 18 July 1996 (18.07.96), figure 3, abstract	1-11
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☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

\* Special categories of cited documents:

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Date of the actual completion of the international search

Date of mailing of the international search report

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## INTERNATIONAL SEARCH REPORT

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## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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